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PUTTING THE SPOTLIGHT ON MATHEMATICS CLASSROOMS

Vesife Hatisaru 

Abstract

This study explores Turkish Grade 6 students' image of mathematicians and their work, stated attitudes to mathematics, and perceived needs for mathematics. Data was collected using the Draw a Mathematician Test (DAMT). This article is based on the drawings where students depicted a mathematics teacher in the classroom that also presented the mode of instruction being used, through students' eyes. Trends that emerged for this sample included, in the drawings, (a) the most common mode of instruction was Highly teacher-directed, (b) no evidence of group work or Highly

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student-centred mode of instruction existed, and (c) a whiteboard and/or books were the most remarkable teaching resources in classroom portrayals.

Keywords: drawings, images, mathematics classrooms, teaching practices

Introduction

Students sometimes perceive mathematics as difficult and abstract with lots of formulas and rules that are unconnected with each other and irrelevant to their lives. These perceptions of students can affect their achievement in mathematics and may keep them from effectively learning mathematics (Boaler, 2015). Teachers' usual request is for students to work harder or to be more engaged with teaching activities. Nevertheless, these requests would be meaningless without explicit strategies for achieving them (Bobis, Anderson, Martin and Way, 2011). For decades, research in mathematics education suggests that teaching different mathematical skills might require teachers to access a range of different instructional strategies (e.g., Schoenfeld, 1992; OECD, 2016). Some countries take this research to heart and construct their mathematics curriculum to necessitate or strongly suggest that teachers use "a variety of teaching strategies." (OECD, 2016, p. 15).

In Turkey, mathematics and science educational policies promote the principles of constructivism and student-centredness. The current primary and lower secondary school mathematics curriculum highlights the importance of active involvement of students in learning processes. The curriculum suggests that teachers embrace various teaching strategies considering students' individual differences and to use appropriate concrete materials and/or ICT technologies when relevant. Among others, the curriculum aims to develop students' mathematical, basic science and technology, and digital competences (The Ministry of National Education, 2018). Students' classroom experiences, however, have remained relatively unexplored through research.

A previous research, led by the author, explored a large group of 1284 lower secondary students' (grades 6 to 8) images of mathematics through examining students' drawings. Drawing on mathematics theories in related literature, the previous research focused on three particular aspects of the image of mathematics: students' stated attitudes (Lane, Stynes and O'Donoghue, 2014; Sam and Ernest, 2000; Wilson, 2011), perceived needs for mathematics (Wilson, 2011), and views about mathematicians and their work (Sam and Ernest, 2000). As previously described by Picker and Berry (2000), the students' drawings fell into two distinct groups: drawings where students depicted a mathematician at work, and drawings where students depicted a mathematician as a mathematics teacher in the classroom. This article presents the data regarding the latter group. The research questions asked were: Through the students' eyes, in mathematics classrooms, (1) What are the modes of instruction? and (2) What resources are used? This will

allow us to understand classroom teaching practices from the students' perspective that could inform teacher education and future research.

The modes of instructions

Depending on whether it is the teacher or the student who plays a main role in the learning process, instructional practices are often grouped into two types: teacher-directed and student-centred (Thomas, Pederson and Finson, 2001). Teacher-directed methods include explanation, demonstration, questioning, and giving examples and/or counter examples. Student-centred methods include group work, problem solving, student presentations, open-ended tasks, games, and peer learning (Bobis et al., 2011). For many years, mathematics teachers have been encouraged to employ student-centred teaching strategies (e.g., Utley and Showalter, 2007; OECD, 2016) rather than the traditional teacher-directed teaching styles (Utley and Showalter, 2007), or to use a blend of teacher-directed methods with student-centred ones to achieve variety in teaching methods (Bobis et al., 2011). Results show that teacher-directed teaching practices “increase students' factual knowledge and their competency in solving routine problems but have no significant effect on their reasoning skills” (Bietenbeck, 2014, p. 143).

The reality of classroom practices, however, is often different. Sometimes, pre-service teachers envision a classroom that is more teacher-directed than student-centred (Utley and Showalter, 2007), and teachers express more student-centred beliefs in the teaching strategies (Isikoglu, Basturk and Karaca, 2009). Accordingly, in mathematics classrooms, students mostly experience a teacher-directed style of teaching (Picker and Berry, 2000); many students sit at desks, passively listen to the teacher who stands in front of the class and lectures, and knows the content and delivers it to the students (OECD, 2016). The drive to explore and integrate the use of current teaching methods into mathematics classrooms is imperative in providing excellent teaching and learning in the mathematics classrooms.

Drawings as a type of measure

In educational research, inquiring into individuals' own conceptions of their educational experiences is vital (Haney, Russell and Bebell, 2004). Although classroom observations or questionnaires have been used in this research for some time, “there is considerable scope for the development of new methods and the wider use of established methods for qualitative studies.” (Fraser, 2014, p. 116). One of the available techniques to document conceptions of individuals about teaching and learning experiences is drawings (Gulek, 1999). Over time, the use of drawings as a measure of the perceptions of young students was found to be a valid (Losh, Wilke and Pop, 2008) and a less expensive alternative to systematic classroom observations (Haney et al., 2004). In mathematics education, the “Draw a Mathematician Test (DAMT)” (Picker and Berry, 2001) patterned from the “Draw a Scientist Test (DAST)” (Chambers, 1983) (see Thomas et al., 2001, for

a detailed review) has been used from early childhood to grade 12 level in many countries on different continents including Europe, the Middle East, Asia, and the United States.

Large-scale assessments such as TIMSS and PISA identify various aspects of school and classroom climate, but these surveys have not been able to identify types of teaching practices (Vieluf, Kaplan, Klieme and Bayer, 2012). Researchers in mathematics education have used DAMT as a way to evaluate teaching in mathematics classrooms (e.g., Pehkonen, Ahtee, Tikkanen and Laine, 2011). In this article, students' (DAMT) drawings and writing are utilized to have information about their perceptions of the teaching and learning practices in mathematics classrooms and the resources used.

The study

The study from which this paper evolved was primarily qualitative and was conducted in Turkish schools in Ankara, Turkey. The DAMT was used (with permission) to collect data by a research team led by the author. DAMT combines drawings with written responses. The front page provides a rectangular area in which participants are asked to draw a mathematician at work. Open-ended items eliciting written responses are provided on the back of the sheet. Relevant to this study is the item: "Look back at the drawing you made of a mathematician at work and write an explanation of the drawing so that anyone looking at it will understand what your drawing means, and who the persons are in it."

To ensure the clarity of the instrument and to decide the time necessary for completing it, we piloted the instrument with 130 lower secondary students at three schools not participating in the actual study. After the pilot, the DAMT was sent to schools by the respective district Directorate of National Education to maximize the response rate. In schools, teachers other than mathematics teachers provided directions to and collected data from the students. We chose to survey students in classes other than mathematics to eliminate a possible mathematics teacher effect. It took students approximately thirty minutes to complete the DAMT. The schools sent the data in a sealed envelope to protect participant confidentiality.

A convenience sample of 1284 students from twenty different lower secondary schools (grades 6 to 8), under the auspices of the Ministry of National Education, participated in the study. The schools were co-educational metropolitan schools located in the centre of the city. In this article, I present the grade 6 student data (169 girls and 162 boys, 331 students total) from students who depicted a mathematician as a mathematics teacher in the classroom.

Data Analysis

In this article, instead of seeking the meaning behind each of the drawings, data analysis focused on identifying patterns in the drawings (Haney et al., 2004). The

extent to which ‘classroom instruction’ is more teacher-directed or student-centred is defined as the mode of instruction. The drawings accordingly were analysed through a four-point scale for coding the mode of instruction depicted in student drawings. Table 1 shows these scales and gives a list of indicators illustrating what constitute each of them.

Scale	Indicators
4-Highly student-centred mode of instruction	<p>Student desks are clustered</p> <p>Students are working in groups/pairs</p> <p>Teacher talk, if any, invites discussion (e.g., praises, questions)</p> <p>Active learning is apparent (students are engaged in an activity)</p> <p>Teacher is with/nearby students.</p>
3-Moderately student-centred mode of instruction	<p>Student desks are usually clustered. If desks are in rows, active learning should be apparent (i.e. students are engaged in an activity)</p> <p>Students are seated in groups/pairs</p> <p>Teacher is at a distance (at blackboard or at teacher’s desk)</p> <p>At least two people (two students or one student-one teacher) are included in the picture and there should be interaction (e.g., content-related talk, engaged in an activity collectively). If only one student is present, active learning should be apparent (i.e. the student should clearly be engaged in an activity)</p>
2-Moderately teacher-directed mode of instruction	<p>Student desks are in rows.</p> <p>Students are seated in rows.</p> <p>If depicted, the teacher is at a distance (at blackboard or at teacher’s desk) and lecturing. If the teacher is not depicted, there should be at least one student present in the picture</p>
1-Highly teacher-directed mode of instruction	<p>Only the teacher depicted, students are not present in the picture.</p> <p>If depicted, student desks are in rows.</p> <p>The teacher is depicted at the blackboard, or at teacher’s desk.</p> <p>Teacher talk, if any, is lecturing or disciplining.</p>

Table 1: Guideline for analysing the mode of instruction in student drawings (Gulek, 1999)

Each scale was unpacked in the form of indicators represented in the drawing and/or writing and coded as ‘3’, ‘2’, or ‘1’. The narrative descriptions of students were used in assisting the coding and allowing to confirm or reconsider the interpretations. When represented, the teaching materials such as whiteboards, books, and concrete materials, and students’ attitudes, feelings, or emotions were also noted. The author and a second researcher in the team independently coded a subsample of the thirty DAMT responses achieving 96% agreement. Disagreements were resolved through discussion to reach consensus. The data was then coded by the author; throughout the analysis, the author consistently attempted to discuss and resolve issues that required further attention for consensus with the second researcher.

In Figure 1 (see Appendix A), typical examples of student drawings and descriptions are given to illustrate Highly teacher-directed (Figure 1a through 1c) and Moderately teacher-directed mode of instructions (Figure 1d through 1f), the two most commonly represented drawings in this study.

Results

The analysis of the grade 6 students' depictions (Table 2) revealed that more than half of the students pictured a Highly teacher-directed (55.58%) and two-fifth of the students pictured a Moderately teacher-directed mathematics classroom (40.48%).

Highly student-centred	Moderately student-centred	Moderately teacher-directed	Highly teacher-directed	Not clear
0	1 (0.30%)	134 (40.48%)	184 (55.58%)	12 (3.62%)

Table 2: The mode of instruction as depicted in drawings (N = 331)

Students were not represented in many of the Highly teacher-directed depictions (e.g., Figure 1a through 1c), with only sixteen drawings including images of students. When depicted, students sit in a row, one behind the other or side by side. Student comments are contradictory to their drawings. One student indicated that she really grasps what the teacher explains to them, and another student wrote that he does well in the mathematics exam and wishes that he would always perform well. However, fourteen other students' attitudes that were reflected in their drawings were more negative. On four drawings, students were disengaged; they were pictured as either misbehaving or listening to music and playing computer games that were not connected to classroom activity. In ten drawings, students were depicted as unhappy because the teacher annoys them.

In these drawings, the teacher was mostly pictured at the whiteboard (161 depictions) or at the teacher's desk (23 depictions) when lecturing, demonstrating, explaining, or disciplining. Both in the drawings and written descriptions, there were strong indications of two roles of the teacher: lecturing and disciplining. Students' descriptions included: "Who will make this calculation?" "Hi, class! We will study Integers today's." "You girl! Why didn't you do your homework? Copy the board down into your notebook, come on!"

In Moderately teacher-directed drawings (e.g., Figure 1d through 1f), images of students were present. In 91 of these drawings, they sit in a row of one or two students, one behind each other or side by side. In others, students were generally portrayed at the board solving mathematics questions. Within this group, in most drawings (n = 85), there were no hints of the students' attitudes or feelings. Among the remaining drawings, students were portrayed as smiley or happy (n = 30). In some drawings, students were depicted as engaged in learning (18 mentions), wherein they raised their hands to volunteer to solve the question on

the whiteboard or listen to the teacher attentively. In only one drawing, students were depicted as disengaged. The creator of this drawing wrote that students were misbehaving. In five drawings, students were pictured as unhappy. As reported by the creators, this unhappiness stemmed from the fact that the depicted students could not solve the question or could not comprehend mathematics. In one drawing, it was written: $1/2 + 3/4$; $2/5 + 4/8$ on the student's paper who looked unhappy because she could not solve it. In another one, the student wrote: "Whoever knows the question gives the answer; others hide under the table."

The teacher was often depicted at the whiteboard at a certain distance from students (116 depictions) or sitting at the teacher's desk (18 depictions). Quotations such as: "Kids, look here [whiteboard]!", "Solve this question." or "Let's solve this equation." were indicative of the teacher's main activity: lecturing. No evidence of group work or any other student-centred methods existed. Nor was there any indication of activity apart from solving mathematics questions, or interaction among students, or between students and the teacher beyond practising mathematics questions such as: " $2/3 - 6/3 = ?$, $7/8 + 8/8 = ?$ " or " $14 + 13 = 27$; $10 + 10 = 20$; $19 - 10 = 9$ ". In fact, the mathematical content of most of the drawings in the whole sample was basic arithmetic.

Sadly, within the whole sample, none of the drawings showed a Highly student-centred classroom. Only in one drawing (Figure 2a) there was slight indications that might suggest a Moderately student-centred mode of instruction. In this drawing, two students were depicted in front of the board, discussing the solution for a question described by the creator.

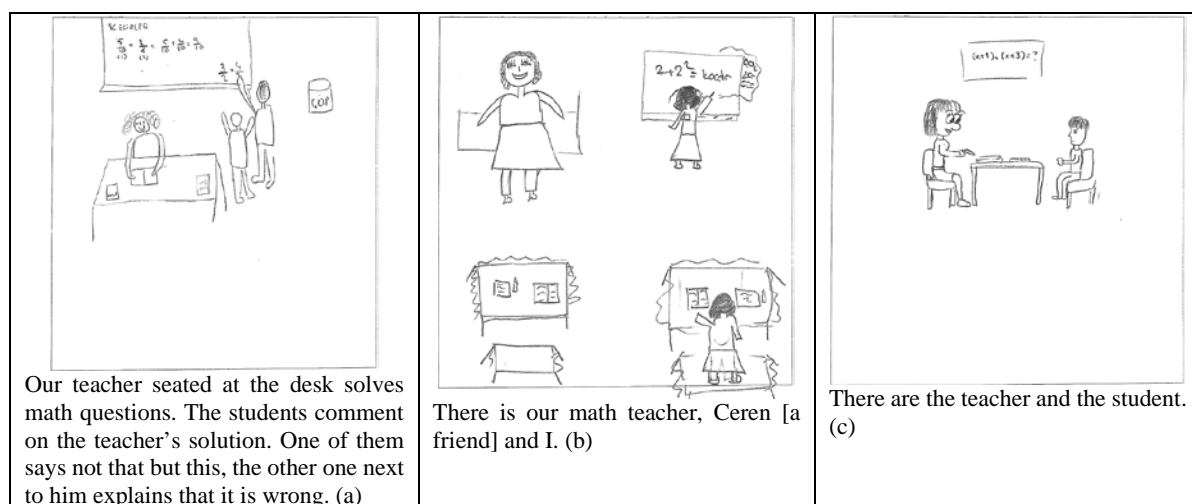


Figure 2: Examples of drawings might suggest Moderately student-centred (a); Moderately teacher-directed or Moderately student-centred instruction (b and c)

The remaining twelve drawings are not included in the four-point scale (3.62%), as it was difficult to decide whether the mode of instruction depicted was Moderately teacher-directed or Moderately student-centred (see Figure 2b and 2c). These drawings picture the teacher standing at the whiteboard (9 depictions) or at teacher's desk (3 depictions). However, in all of them, students were next to

the teacher, and sometimes with smiley faces. This possibly indicated that they were quite happy doing mathematics, but there is no hint as to whether there was a content-related discussion between the teacher and students based on a particular task or a student-centred task was in use.

In the depictions, a whiteboard (301 mentions) or books (19 mentions) were the most remarkable teaching resources. Only in one depiction a smart board and in eight depictions concrete materials such as a ruler (7 mentions), geometric objects (2 mentions), a compass, a protractor, or a miter (3 mentions) were present. In ten depictions there was no indication as to the teaching resources that might have been used. Different materials and tools such as calculators, computers, or technological or digital tools did not appear in any drawings.

The resources shown on the drawings did not vary according to the mode of instruction, but students' attitudes or feelings did. In drawings where the mode of instruction was identified as Moderately teacher-directed or potentially Moderately student-centred, students described themselves as being happier than in drawings where the mode of instruction was Highly teacher-centered.

Concluding comments

The analysis of student drawings and writing revealed that 96% of students depicted either Moderately or Highly teacher-directed mathematics classrooms, mostly a whiteboard and/or books represented in drawings as the teaching and learning resources, and there were strong references to the computational manipulations. Students' (DAMT) drawings in the previous study fell into two distinct groups with the present article only providing the data regarding the drawings that clearly represented a mathematics teacher in the classroom. The results are therefore being regarded in isolation from the remaining data from the overall study and should be interpreted with caution. Also, the sample might not be representative of the entire population of six grade students within Turkey or in other countries. Nevertheless, the study contains three implications and directions for future research.

First, my observation is that students' depictions might mirror their classroom experiences. Most students pictured their actual mathematics teachers and classrooms, and some expressed their teaching and learning practices. The classroom environment that emerged from these depictions are worrying because these teacher-centred approaches negatively impact students' attitudes (Hasni and Potvin, 2015), seeing mathematics mostly as "numbers" or "lots of formulas" (Boaler, 2015) and making it difficult for students to remain engaged in mathematics (European Commission [EC], 2011). Such trends have longer term implications for students' mathematics learning and it is my recommendation that this area be a focus of further research.

As Losh et al. (2008) found, students in this study took the drawing task seriously and put some considerable amount of effort and thought into completing it. The

student drawings in this study “can provide a valuable catalyst to document, change, and improve what goes on in [Turkish] schools.” (Haney et al., 2004, p. 243). Second, I suggest that teachers can use drawings to access and become aware of student views about mathematics teaching and learning and use such understanding as a basis for reflecting on their own practices. Student drawings might also inform policy makers about the impact of curriculum revisions on classroom teaching.

Results from TIMSS studies show that Turkish lower secondary students have certain shortcomings in mathematics achievement, being far below the OECD average (Mullis, Martin, Foy and Hooper, 2015). Finally, I believe future studies on how students’ classroom experiences correlate with their performance would contribute our understanding on the possible factors behind student low performance in mathematics. TIMSS studies also show that between-school variation in Turkey is quite large and explain more than 60% of differences in student achievement (EC, 2011). The previous study, part of which is presented here, was implemented in twenty metropolitan schools. Students’ experiences of classroom mathematics in disadvantaged or remote schools would extend the findings of this study.

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Appendix A: Typical examples of student DAMT responses

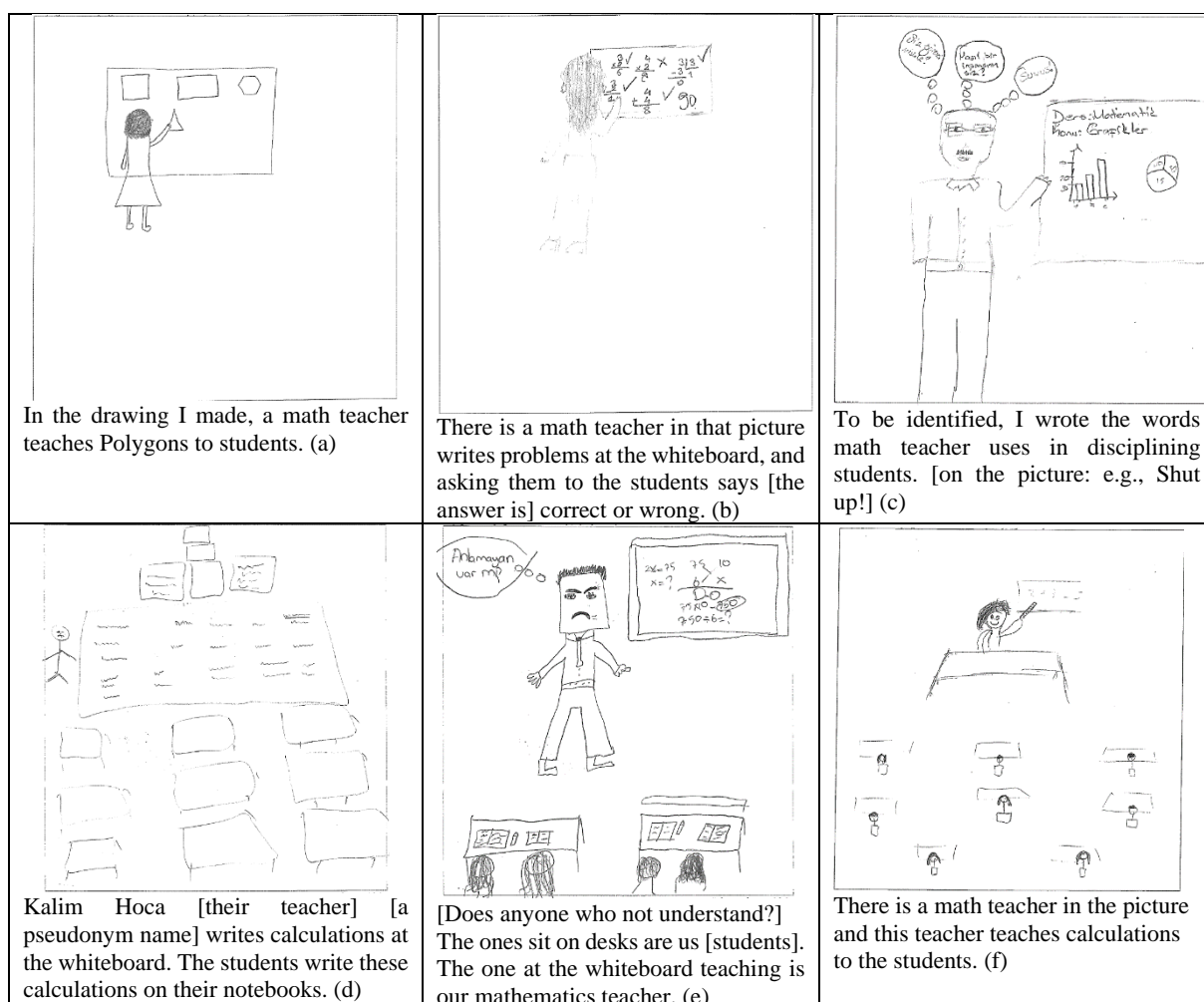


Figure 1: Examples of drawings and descriptions illustrating Highly teacher-directed (a through c) and Moderately teacher-directed (d through f) mode of instructions

LEARNING TO ENHANCE EMERGENT BILINGUALS' ACCESS TO MATHEMATICS: ELEMENTARY TEACHERS EXPERIMENTING WITH THE CLINICAL INTERVIEW

Hanna Haydar 📧

Abstract

We report in this paper on a study of prospective and beginning teachers learning to conduct clinical interviews to enhance emergent bilingual students' access to mathematics. The study is conducted within the context of a teacher education program in New York City. The student populations in the U.S. schools continue to become more

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